No. 705,685. Patented July 29, 1902.

J. LYONS.

TELEPHONY.

(Application filed Sept. 2, 1899.)

(No Model.)

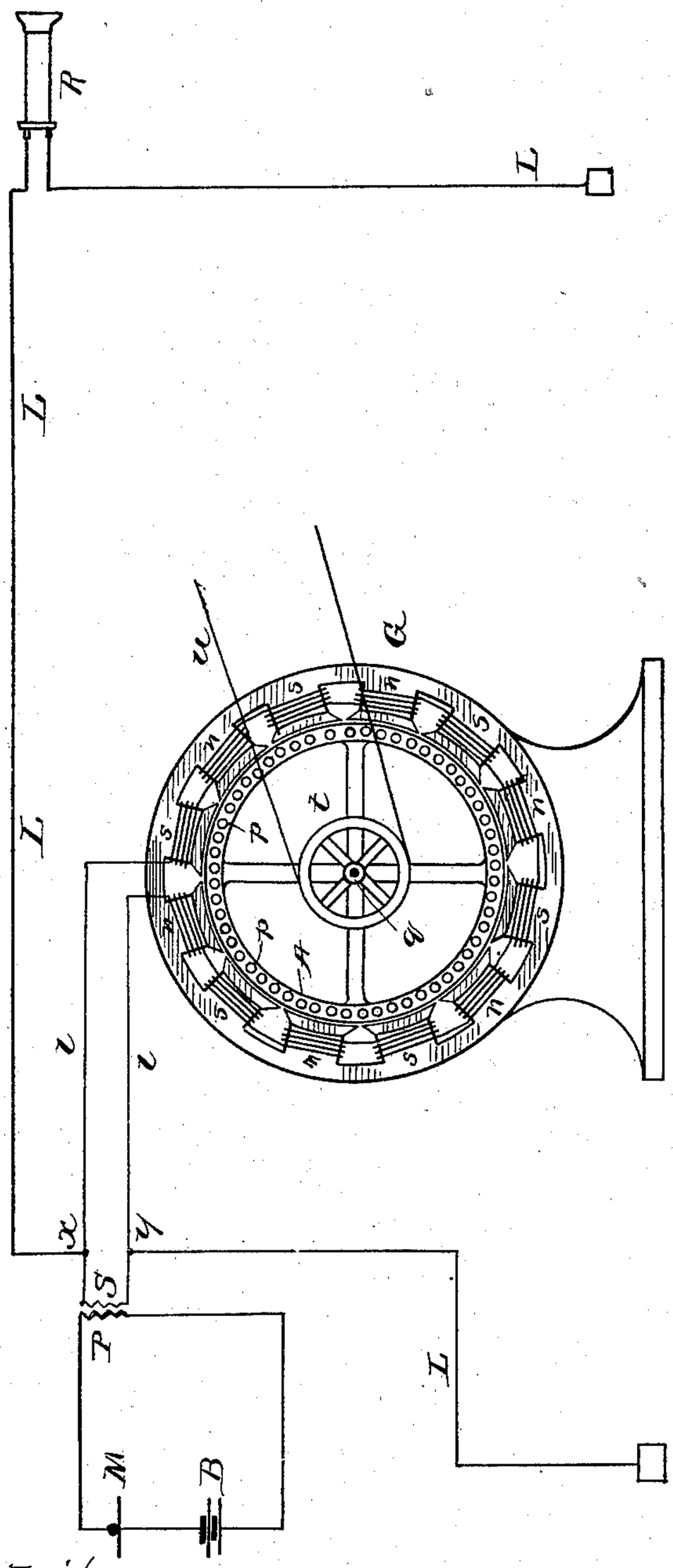

Fig. 1.

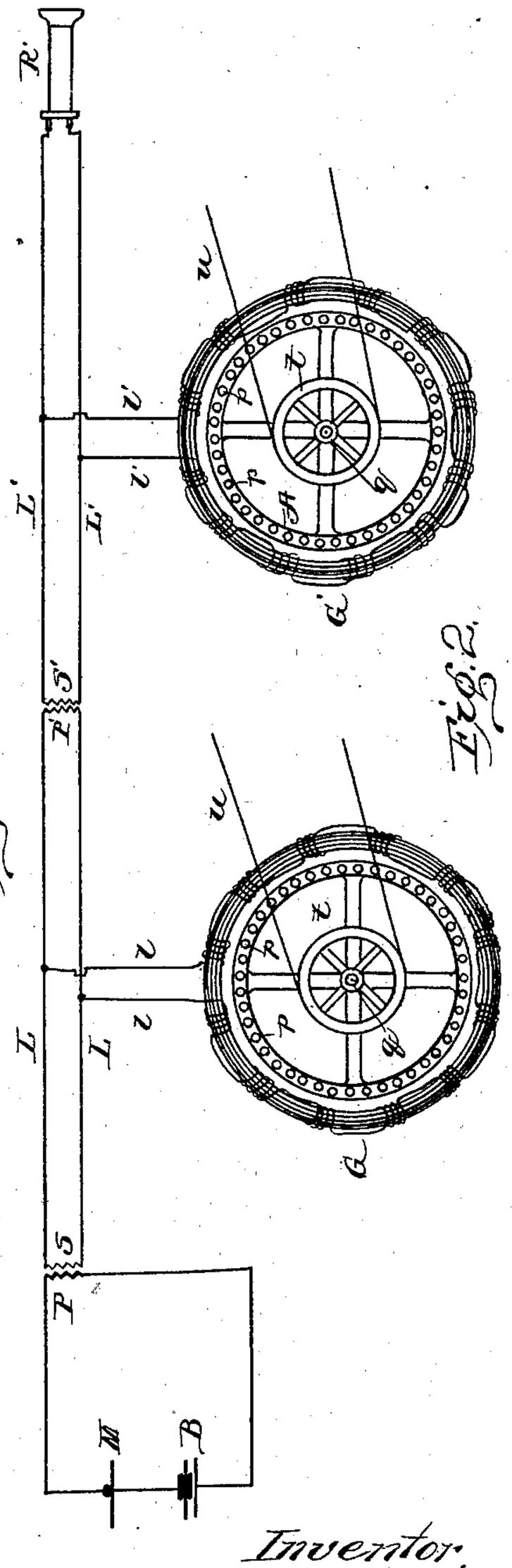

Fig. 2.

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UNITED STATES PATENT OFFICE.

JOSEPH LYONS, OF CHARMIAN, PENNSYLVANIA, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONY.

SPECIFICATION forming part of Letters Patent No. 705,685, dated July 29, 1902.

Application filed September 2, 1899. Serial No. 729,393. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH LYONS, a citizen of the United States, and a resident of Charmian, Washington township, Franklin county, State of Pennsylvania, have invented certain new and useful Improvements in Telephony, of which the following is a specification.

My invention has reference to improvements in telephony; and it consists in a method of and apparatus for reinforcing telephone-currents imposed upon a line in any way or manner. The reinforcing of the faint telephone-currents I accomplish by reducing the apparent resistance of the line to these currents continuously, and practically to any desired extent. In accordance with my invention the telephone-currents are primarily caused to produce an alternating field or fields of force varying in frequency and intensity with the frequency and the variations of intensity of the telephone-currents, and within such field or fields there are rotated electric circuits that are closed upon themselves with a speed that exceeds a certain critical speed. By the rotation of such circuits within the initial magnetic field or fields the electromagnetic reactance of the telephone-circuit is reduced, whereby the initial field or fields and the exciting-currents are reinforced.

Machines for reinforcing faint alternating currents of one definite frequency by causing them to produce an alternating magnetic field or fields and rotating within the latter circuits closed upon themselves with a speed exceeding a certain critical speed have heretofore been suggested for use as constant-potential alternating-current generators, and such machines are set forth in United States patent to Hutin and Leblanc, No. 606,762, dated July 5, 1898. Such machines, however, have heretofore been used only each for the reinforcement of an alternating current of one definite frequency, and the speed given to the closed circuits was calculated and determined with reference to the frequency of the single current that was led to and reinforced by the machine. The rule which governs the operations of such machines is that if the frequency of the alternating current led to the machine is designated by $\frac{1}{T}$ and if the number of poles of the field excited by these currents is designated by $2n$, then in order that the initial field and the initial current be reinforced the number of revolutions of the circuits closed upon themselves must exceed the quantity $\frac{1}{n\,T}$. This rule may also be stated in these words: The number of rotations of the rotor must exceed the frequency of alternations of the alternating current that excites the stator divided by half the number of poles of the latter. My invention is based upon the utilization of the principle embodied in these reinforcing-generators for the reinforcement of multiperiodic varying currents—that is to say, the reinforcement of telephone-currents.

In the practice of telephony alternating currents of constantly-varying periodicities and intensities are generated, and it has been found that the currents corresponding to the highest pitch of sounds uttered against the telephone-transmitter rarely exceed the frequency of eight hundred per second. All other frequencies that occur in practice are below eight hundred per second. In order to reinforce alternating currents of the frequency of eight hundred with a machine of the Hutin and Leblanc type, if the same has, for instance, twelve field-poles, the circuits closed upon themselves have to be rotated with a speed exceeding one hundred and thirty-three revolutions per second. If this is done, then not only the currents having the frequency eight hundred will be reinforced, but all other currents of a lower frequency will also be reinforced, and upon the recognition of this fact my invention is based. Accordingly my invention is practised by passing the faint telephone-currents at any point on the line through the field-coils of a machine of the Hutin and Leblanc type and rotating the armature of such machine with a speed exceeding the number of periods of the highest frequency current that

occurs or is likely to occur in telephony divided by half the number of poles of the field-magnet. By this process the lower-frequency currents are more reinforced than the higher-frequency currents; but this does not vitiate the reproduction of speech, but, on the contrary, improves the reproduction, since lower-frequency vibrations must be of higher amplitude than those of higher frequency in order to produce sounds of the same intensity as the latter.

In the accompanying drawings, Figure 1 is a diagram illustrating my invention as applied to long-distance telephony with an unbroken line, and Fig. 2 is a diagram illustrating my invention as employed for long-distance telephony with a line divided into sections.

Like letters of reference indicate like parts throughout the drawings.

Referring now to Fig. 1, there is shown a local circuit containing a microphone M, a battery B, and the primary P of an induction-coil. The secondary S of this induction-coil is connected with the line L L L, having a magneto telephone-receiver R at the distant station. This line is here shown as grounded at both ends; but it will be understood that it may be a complete metallic line and that it may be either overhead or underground or submarine. At two points *x y* this line is tapped by wires *l l*, leading to and completing the circuit of the field-coils of a reinforcing alternating-current generator of the Hutin and Leblanc type above referred to. This reinforcing-generator G is ordinarily composed of a stationary iron field-ring having inwardly-projecting radial pole-pieces *n s*. The pole-pieces are wound alternately reversed and are here shown as connected in series, (although they may be connected in multiple arc,) so that a current which produces in one pole-piece a north pole will produce in the next succeeding and in the next preceding pole-piece a south pole. This is indicated in the drawings by the letters *n s*. The rotary part of the reinforcer is ordinarily made of an iron ring, faced on each side with a flat annulus A, of copper, and the iron ring as well as the two copper rings are perforated, so as to receive copper pins, rods, or bars *p*, riveted at each end to the copper rings; all in the manner now well known, and set forth in detail in the Hutin and Leblanc patent above referred to. The copper rings A A, together with the pins *p*, form a great number of electric circuits of low resistance closed upon themselves, and this system is secured upon a spider, as indicated, and the whole is mounted upon a shaft *q*, carrying a pulley *t*, around which passes a belt *u*, by which motion is given to the shaft from any suitable source of power.

The system as thus represented is operated as follows: Speech uttered against the microphone M causes alternating electric currents to be generated in the secondary S of the induction-coil. One branch of these currents passes through the field-coils of the reinforcing-machine by the conductors *l l*, and another branch passes to the line L L. Both current branches are exceedingly weak, and the branch passing to the line is too weak to cause an audible reproduction of sounds in the telephone-receiver R if the line exceeds a certain length; but if now the rotor of the reinforcing-machine is rotated with such speed that its number of rotations per second exceeds the number of periods of the currents due to the sound of highest pitch that is uttered against the transmitter divided by half the number of poles of the field then the initial and exceedingly weak alternating field excited by the telephone-currents is reinforced, and these currents themselves are reinforced. This reinforcement of telephone-currents may be carried practically to any desired extent, depending upon the size and speed given to the reinforcing-generator and also depending upon the electromagnetic reactance of the reinforcer. This reactance should be made as small as practicable, and for this purpose the amount of iron entering into the construction of the machine should be made very small, and the iron, if employed at all, should be highly laminated, as is usual with machines of this character. It will be understood that the reinforcing-machine may be in series in the line instead of in a branch derived therefrom.

In the ordinary system of telephony the faintness of the telephone-currents is due to the great apparent resistance of the telephone-circuit, and for this reason telephony can only be successfully practiced over comparatively short lines. With my improved system there is no practical limit to the length of the telephone-line, since whatever that length may be its apparent resistance is so largely reduced by the reinforcing operation that speech can be transmitted over very long lines with the same loudness as is now attained upon comparatively short lines.

In Fig. 2 the main line is divided into two parts L L and L′ L′, connected inductively by the induction-coil P′ S′. In a branch *l l*, derived from the line L L, there is a reinforcing-machine G, and in a branch *l′ l′*, derived from the line L′ L′, there is another similar reinforcing-machine G′. This division into sections, which may be carried much farther, permits the use of small reinforcing-machines upon moderately long sections of lines and the practice of telephony over very long distances. When a line is thus subdivided into sections, it is not necessary that each section be either complete metallic or grounded. Some sections may be completely metallic, and others may be grounded. Nor is it necessary with this arrangement that the two or more reinforcing-machines be all driven at the same speed. It is all sufficient if each machine is driven above the critical

speed above indicated. So long as this rule is observed it is immaterial what the speeds of the reinforcing-machines are.

While my invention is well adapted for use in connection with the ordinary magneto telephone-receivers, it is preferable to use telephone-receivers without iron or steel cores, and, similarly, it is preferable to use induction-coils without iron cores. Altogether the electromagnetic reactance of the system should be made as small as possible.

I desire it to be understood that I am not confined to the use of the reinforcing-machine hereinbefore indicated, and particularly described in the Hutin and LeBlanc patent, No. 606,762, since I may use any other reinforcing-generator operating to reduce the reactance of the line and of its appurtenances for the various frequencies of telephone-currents. It will also be understood that instead of rotating the closed circuits these may be stationary and the field-magnet structure be rotated; also, that I may omit the iron cores entirely or retain them either in the stator or in the rotor of the reinforcing-machine.

In the practice of telephony it has been observed that speech can be transmitted with sufficient distinctness even though some portions of the sounds uttered against the transmitter are not faithfully reproduced or are altogether lost in the receiver. Particularly is this true when some of the sounds of highest pitch are lost. This being the case, it is in my system not absolutely necessary that particular notice be taken of the alternating currents of the highest frequencies that occur in the transmission of speech. In other words, it is not absolutely necessary to reinforce these very highest frequency currents. It is practicable to lose the sounds corresponding to them without materially affecting the clearness of reproduction. This enables me to rotate the rotor of the reinforcing-machine with lower speed than would be necessary if it were attempted to reinforce all high-frequency currents.

It will now be understood that wherever I speak in the foregoing description and in the claims of the highest-frequency currents that occur in telephonic transmission or that are thrown upon the line I mean those highest-frequency currents which are still essential to the intelligible reproduction of the sounds uttered against the transmitter.

I do not herein claim the arrangement of apparatus which I have described and by which my method of reinforcing telephone-currents is or may be practiced, since this is claimed in an application filed April 23, 1902, as a division hereof.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. The improvement in the art of telephony, which consists in causing telephone-currents produced upon a line to establish an initial magnetic field or fields the lines of force of which intersect circuits closed upon themselves, and producing a relative movement between the field structure and closed circuits with a speed exceeding the number of periods of the telephone-current of highest frequency divided by half the number of poles of the field, substantially as described.

2. The method of reinforcing telephone-currents upon a line, by causing such currents to produce an initial magnetic field, and rotating within the latter a closed electric circuit or circuits, with a speed exceeding the number of periods of the telephone-current of highest frequency, divided by half the number of poles of the field, substantially as described.

3. The method of reinforcing telephone-currents upon a line, by causing such currents to produce an oscillating magnetic field of force, and rotating within the latter a circuit or circuits of low resistance, closed upon themselves, with a speed exceeding the number of periods of the current impulses of highest frequency, divided by half the number of poles of the field, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOSEPH LYONS.

Witnesses:
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EDWIN S. CLARKSON.